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XXVI

EXPEDITION OF THE CALIFORNIA ACADEMY OF SCIENCES TO THE GULF OF CALIFORNIA IN 1921*

LAND AND FRESHWATER MOLLUSKS

BY

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The southern end of the Peninsula of Lower California, known as the "Cape Region", has long been known for its remarkable land-snail fauna. The species are probably all confined to the region but several of them bear a striking similarity to forms found in Peru. Whether this indicates a closer connection, either directly by land or through favorable ocean currents, than has ever existed with the mainland of Mexico close by, is a problem which will bear careful study.

The first species made known to science from Lower California reached European conchologists many years ago without definite locality data. The peculiarities of the fauna were not suspected until the collection made by John Xantus de Vesey in 1860-61 reached the hands of W. G. Binney. He described several striking species and recognized the Peruvian affinities of others.

The remainder of our knowledge of this branch of science is largely due to the efforts of members of expeditions sent out

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*A map showing all the islands, etc., visited by this Expedition will be found in Vol. XII, No. 6, of these Proceedings, copies of which can be supplied at nominal cost.

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at various times by the California Academy of Sciences. The collections were studied by Cooper and Dall and several papers were published on the results.

But all of the collections together heretofore made probably constitute but a small part of the wonderful series brought back by the expedition of 1921. This resulted from the untiring efforts of every member of the party. The expedition visited a great many localities from which land shells had not before been secured and, because work was chiefly confined to the islands of the Gulf of California, many novelties were found. The Cape Region, so rich in species of Bulimulus, was not visited, but in 1919 Mr. Joseph R. Slevin travelled extensively there and brought back numerous specimens of some of the better known species. The results of that work are incorporated herein.

The work of identification has been made much less laborious by having the magnificent collection of the late Henry Hemphill for consultation and reference. He had been able to secure authentic specimens of most of the better known species through his close friendship with many of the older conchologists.

Genus **Bulimulus** Leach

The species of this genus which live in Lower California and on the islands of the Gulf fall into a natural group which is characterized by a heavily costulate nucleus, and in anatomical detail. A subgenus, Orthotomium Cross & Fisher, with *B. sufflatus* as type, has been made for the group.[1] Shape and size vary within most diverse limits but nuclear characters seem to remain constant; it argues for a common ancestry and a very long isolation. The species of the islands are related only to nearby peninsular forms and in no case to those of the mainland of Mexico. The genus was not found on the northern islands of the Gulf from which may be inferred that these have not had a recent connection with the more southern ones of the Cape Region.

The fauna is divisible into five fairly well defined groups typified by the following characteristic species:

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[1] See Pilsbry, Man. Conch. 2nd Ser., Vol. XI, p. 125.

Group of B. sufflatus
" " B. montezuma
" " B. artemesia *(Plicolumna)*
" " B. inscendens
" " B. spirifer *(Sonorina)*

Group of B. sufflatus

The species of this group are known by their globose shape and non-reflected peristome. Through *B. levis* they show intergradation with the forms having a more elevated and acutely conical spire.

The following list shows the number of names which have been given in the group. Those in italics are believed to be synonyms or unrecognizable.

B. vesicalis (Gould)
B. sufflatus (Gould)
B. juarezi (Pfeiffer)
B. insularis (Cooper)
B. chinchensis Cooper
B. recognitus Mabille
B. pilula (Binney)
B. cooperi Dall
B. decipiens Cooper
B. levis Dall

The species are confined chiefly to the lower Cape Region. Pilsbry, in 1897-98[2] monographed the group as then known and no additional names appear to have been added since. The only changes which are suggested through the present study are as follows:

The names *insularis* and *chinchensis* were given by Cooper,[3] to supposed subspecies of *sufflatus*. The differentiating characters, however, if present are not well described. It is not believed that sufficient well labelled material has accumulated for a racial study of the group and both above names would better be dropped. The original specimens of *insularis* came from Espiritu Santo Island and may represent a distinct species but this has not as yet been shown. The 1921 Expedition failed to find it there. A single immature individual was taken on Ceralbo Island, farther south, by Mr. I. M. Johnston but no characters are perceived to differentiate it from *sufflatus*. Of the latter the Academy collection contains two specimens from La Paz collected by Woodworth and three from Ensenada de la Palma in the Cape Region collected by Joseph R. Slevin in 1919.

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[2] Man. Conch. Vol. XI, 1897-98, pp. 135-141.

[3] Proc. Calif. Acad. Sci., 2nd Ser., Vol. III, 1893, p. 212, pl. 14, fig. 6; Vol. IV, p. 140, pl. 5, fig. 10.

Mabille's species, *recognitus,* cannot be recognized in spite of the name. It should probably be placed in the synonymy of *sufflatus.*

There is a possibility that *cooperi* and *decipiens* refer to the same species. Both names were published in 1895, the latter having precedence of two months according to Pilsbry.[4] *B. decipiens,* however, was described from immature individuals and one would have great difficulty recognizing the species from the description; it has not been figured.

B. pilula (Binney) was described from Todos Santos Mission in the Cape Region (west side) and Margarita Island which forms part of the outer boundary of Magdalena Bay. The latter locality is very probably erroneous.

Group of **B. montezuma**

To this group belong the very large bulimuli confined chiefly to the Cape Region. The names which have been given in the group are as follows,—synonyms and unrecognizable forms being in italics:

B. montezuma Dall
B. proteus (Broderip)
B. excelsus (Gould)
B. sinaloæ Pilsbry
B. elatus (Gould)
B. pallidor (Sowerby)
B. vegetus (Gould)
B. vegexpiza Cooper
B. striatulus Dall
B. acholus Mabille
B. cosmicus Mabille
B. baileyi Dall
B. gabbi Cross & Fisher
B. slevini, n. sp.
B. santacruzensis, n. sp.
B. ceralboensis, n. sp.
B. johnstoni, n. sp.

A monograph of the group was published in 1897-98 by Pilsbry[5] and no additions or emendations seem to have been made until now. In the preparation of the following report the only modifications which appear necessary are as follows:

There is practically no basis for separating the species *excelsus* (Gould) and *pallidor* (Sowerby), when the descriptions and figures of Pilsbry are closely compared. It seems that the former name has been restricted to the long slender specimens of pale flesh color. A somewhat larger and more robust form was named subspecifically, *sinaloæ* by Pilsbry, the specimens having come presumably from the State of Sinaloa, Mexico. Many individuals in the Academy collection from La Paz, San Jose del Cabo and Ensenada de la Palma, cannot be distinguished from the figures of *sinaloæ;* the name is therefore considered of little systematic value. It is very doubtful if Gabb's specimens, upon which the subspecies was founded, actually came from Sinaloa; unless definite evidence can be produced to show that this is true, the writer would be inclined to discredit the record because of the loose manner in which he kept his locality records on his 1867 trip.

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[4] Man. Conch. Vol. XI, p. 151 under Plicolumna.

[5] Man. Conch. 2nd Ser., Vol. XI, 1897-98, pp. 141-148.

White specimens with the last whorl more horizontally expanded have been referred to *pallidor* but there is every gradation between the two forms in the Academy's series from the peninsula.

But the dark brown form with open umbilicus, granular surface due to spiral striations, low spire, and slightly expanded peristome, named *striatulus* by Dall[6] appears to be a decidedly distinct species. It has been listed from Carmen and Margarita islands. The Academy has large numbers of specimens from the latter place but it was not found on Carmen Island by the 1921 Expedition and it is very doubtful if it occurs there; the members of the party covered the territory well and collected almost 400 specimens of another species of Bulimulus but not one of the *montezuma* group.

Mabille's species, as usual, are entirely unrecognizable.

B. baileyi Dall has been credited to Cape San Lucas but it is very doubtful if it occurs there.

1. **Bulimulus santacruzensis** Hanna, new species

Plate 7, figures 12-15

Shell similar to *B. slevini* of Monserrate Island but larger on the average; peristome broader; columellar fold much more strongly developed but no indication of a plication on the axis; spiral sculpture absent; body wall with a callous deposit connecting the terminations of the peristome.

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[6] Proc. U. S. Nat. Mus., Vol. 16, 1893, p. 640, pl. 72, fig. 3.

Type: No. 1030; paratypes, Nos. 1031-1033; Mus. Calif. Acad. Sci., collected by members of 1921 Expedition on **Santa Cruz Island, Gulf of California,** May 27, 1921. The type lot consists of 31 specimens, collected by Fred Baker, J. C. Chamberlin, I. M. Johnston, V. Owen, J. R. Slevin and E. P. Van Duzee.

Measurements in millimeters

Altitude	Diameter	Altitude of aperture
38.	20.6	20.1 (Type)
41.2	20.	21.9
37.8	20.	18.9
33.3	17.	17.
31.7	17.3	15.7
34.	18.3	16.5
36.5	18.6	18.
39.4	21.5	20.8
40.1	22.6	20.5

This species varies in size to an excessive degree and some large individuals approach *B. pallidor* (or *excelsus)* from La Paz. But the proportions differ; the smallest individual of the latter among a large number in the Academy collection measures: altitude, 35.5 mm.; diameter, 21.5 mm.; altitude of aperture, 20.6 mm. But the chief difference is in the reflected peristome; in *santacruzensis* it is broadly revolute on the outer wall, while in the *pallidor-excelsus* group it is merely thickened on the inside and slightly expanded in this region. Undoubtedly *B. slevini* is a closely related form but in the large series of both, there appears to be a tendency toward intergradation in only two or three individuals.

2. **Bulimulus slevini** Hanna, new species

Plate 7, figures 16-19

Shell short but robust, composed of about 6½ whorls, slightly rounded and with suture impressed lightly; spire with upper four whorls regularly conical but below this it becomes convex due to unequal rate of growth during later stages; color brownish flesh-color when alive, aperture not differing from remainder of shell; surface very slightly glossy when alive, roughened by growth lines which are usually more regular than in other species of the group; spiral sculpture absent in type, when present, exceedingly faint; nucleus composed of two costulate whorls; aperture rounded, with an indistinct fold on the columella but no spiral lamina as in Sonorina; peristome reflected and revolute as though rolled back, umbilicus rimate.

Type: No. 1034; paratypes, Nos. 1035-1038; Mus. Calif. Acad. Sci., collected by members of 1921 Expedition on **Monserrate Island, Gulf of California,** May 24, 1921. The type lot consists of 51 specimens collected by Joseph R. Slevin, E. P. Van Duzee, J. C. Chamberlin, V. Owen and I. M. Johnston.

Measurements in millimeters

Altitude	Diameter	Altitude of aperture	
33.7	16.5	17.1	(Type)
31.2	16.5	17.1	
34.6	17.1	16.8	
35.	16.	17.8	
29.5	14.4	14.6	
29.2	15.5	15.8	
30.6	17.1	16.9	

This species does not show as wide a range of variation in size as some others. It is related closely to *santacruzensis* and *ceralboensis* but differs as pointed out under those forms. In a thorough biologic study intergradation of the three might be demonstrated and then the latter would become subspecies; but the material is not now available to show this in every character. *B. johnstoni* is also related to this but is constantly smaller. All four differ from the other members of the *montezuma* group in the submergence of spiral sculpture; nevertheless, they appear to belong therein rather than to any other which has been defined. The complete absence of denticle or plait on the axis removes them definitely from Sonorina. *B. gabbi* Cross & Fisher, is similar in size to *B. slevini* but the very characteristic spiral rows of beads or minute tubercles make confusion therewith unlikely.

Named for Joseph R. Slevin, who was in charge of the Expedition.

3. **Bulimulus ceralboensis** Hanna, new species

Plate 7, figure 11; plate 11, figures 2, 4

Shell of medium size, similar in shape to the slender form usually referred to *B. excelsus* in accordance with Gould's type specimen, but that species is much larger; peristome thickened within and expanded on the outer wall slightly; not revolute as in the species from Santa Catalina, Santa Cruz and Monserrate islands farther north; columellar fold not developed in the slightest degree; apex blunt; nucleus costulate but not sharply defined from remainder of shell; transition into lower whorls gradual; spiral striation scarcely visible on weathered specimens (as the type) but fine and regular on live shells; this striation extends entirely to the apex and on the nuclear whorls is very delicate and regular producing a shagreen effect; the costæ of the first whorl of the nucleus are broken up making a series of pits as though it had been sculptured with a ball pein hammer; this condition has not been noted on any other species, although in *gabbi* and *excelsus* the apical costæ become wavy instead of straight.

Type: No. 1021; Mus. Calif. Acad. Sci., collected by Joseph C. Chamberlin west of Ruffo's ranch house, **Ceralbo Island, Gulf of California,** June 7, 1921. Paratype, No. 1022, collected at El Mostrador, same island, by Mr. Chamberlin. Two other specimens were collected on the same island.

Measurements in millimeters

Altitude	Diameter	Altitude of aperture
36.4	19.4	17.4 (Type)
36.2	19.2	17.3
36.8	19.7	19.

This species is undoubtedly related closely to the *excelsus-pallidor* complex although it is smaller than usual in that group; the shape and expansion of aperture show the relationship; but the absence of columellar fold and the characters of the nucleus distinguish it readily from any species known to the writer.

4. **Bulimulus johnstoni** Hanna, new species

Plate 7, figures 1-6; plate 11, figure 3

Shell small, light flesh color, darker on the apex; composed of almost six rounded whorls; nucleus heavily costulate, the costæ widely separated; interspaces flat and spirally striated but the striæ of unequal strength; nuclear whorls two, sharply separated from remainder of shell; body whorls roughened by heavy, unequal growth ridges and these crossed by numerous fine spirals; thus the shell is not glossy; peristome broadly reflected all around and deeply revolute, the terminations connected across the body whorl by a heavy callous deposit; columella with an indistinct fold but no trace of a plication or denticle as in the Sonorina group.

Type: No. 1024; paratypes, Nos. 1025-1029; Mus. Calif. Acad. Sci., collected on **Santa Catalina Island, Gulf of California**, by members of the 1921 Expedition. The type lot consists of about 2000 specimens taken by I. M. Johnston, E. P. Van Duzee, Virgil Owen, J. R. Slevin, J. C. Chamberlin and Fred Baker.

Measurements in millimeters

Altitude	Diameter	Altitude of aperture
29.1	15.3	16.6 (Type)
29.1	16.2	16.
28.1	13.8	14.8
31.5	16.1	16.
27.5	15.6	16.
25.3	14.3	14.3

This species is very evidently a dwarfed member of the *montezuma* group. It is so distinct from others that comparison is hardly necessary.

Section **Sonorina** Pilsbry

Sonorina Pilsbry, Nautilus Vol. 9, 1896, p. 114; type *B. spirifer* Gabb. Pilsbry, Man. Conch., 2nd Ser. Vol. XI, 1897-8, p. 155.

The name Sonorina was used to replace Leptobyrsus Cross & Fisher[7] because that name was preoccupied by Leptobyrsa Stål in Entomology. The group is characterized by the presence of a tooth on the axis of the shell, usually only partially or not at all visible from the aperture.

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[7] Moll. Terr. et Fluv. Mex. 1, 1874, p. 475.

All of the species are confined to Lower California and the adjacent islands of the Gulf. The following is a complete list, synonyms or unidentifiable species being in italics:

B. spirifer (Gabb)
B. rimatus (Pfeiffer)
B. bryanti Cooper
B. orthelasmus (Pilsbry)
B. lamellifer (Pilsbry)
B. veseyianus Dall
B. dentifer (Mabille)
B. lapidivagus (Mabille)
B. subspirifer (Mabille)
B. dismenicus (Mabille)
B. ximenez, n. sp.
B. bakeri, n. sp.
B. chamberlini, n. sp.

5. **Bulimulus dentifer** Mabille

Plate 8, figures 16-20

Bulimulus (Leptobyrsus) dentifer Mabille, Bull. Soc. Philomath. (8) Vol. VII, p. 67, 1895.—Pilsbry, Man. Conch., Vol. XI, p. 161, 1897-8.

The Academy Expedition found this species exceedingly abundant everywhere on Tortuga Island, near the center of the Gulf of California from where it was originally described. It was particularly common inside the crater of the extinct volcano which forms the center of the island. Nearly a thousand specimens were collected, many of them alive. The original description (quoted by Pilsbry) mentions microscopical spiral striæ as though they were present over the entire shell, but they are visible only on the uppermost two or three whorls (exclusive of the nucleus) and rarely there. The nucleus is composed of one and a half to one and three-fourths whorls, marked by sharp, evenly spaced, vertical riblets. The axial denticle is partially visible from the aperture and is a high, lamellar plait, the outer margin being sinuous. Living shells are uniform brown with the expanded outer lip having a slight purplish tint. Variation in size is excessive as shown by the following table, yet the largest specimen is smaller than any other species of the region except *B. chamberlini.*

Measurements in millimeters[8]

Altitude	Diameter	Altitude of aperture
23.7	12.8	11.5
23.4	11.8	11.3
23.	11.	10.8
22.5	9.8	10.
19.2	9.6	9.2

The genitalia are of the general form of *B. pallidor* Sowerby[9] as figured by Pilsbry. The elements are long and slender, the short retractor muscle being attached to the tip of the penis. It is attached to the body wall near the upper end of the mantle cavity. The vas deferens is attached to the base of the penis and is a very slender, unconvoluted duct.

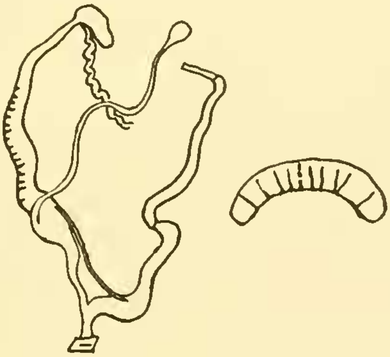

Fig. 1. Genitalia and jaw of *Bulimulus dentifer* Mabille

The spermatheca is globular and on a duct fully as long as the oviduct. The jaw is composed of about 12 heavy, flat, irregular plaits; radula with 30-1-30 rows of teeth. The main blood vessel of the mantle has branches on each side about equal in number and size.

The original description, like others of Mabille's, is entirely unrecognizable; he did not furnish illustrations and failed to make comparison with any known form. Under ordinary circumstances it would be necessary to discard his name completely, an unavoidable course which must be adopted with his other Lower California bulimuli; but in this case there is almost certain assurance that we are dealing with the same species Mabille had. Tortuga Island is small and it is improbable that two species of Bulimulus inhabit it. As a general thing it would seem unwise to refer specimens to unrecognizable species unless, as in this case, certain limitations, geographic or otherwise, enable them to be fixed with reasonable certainty. Pilsbry's forceful comments upon Mabille's "dilettante trash" are well worth consulting in this connection.[10]

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[8] The specimens measured are the plesiotypes figured herein and were selected from the lot of about 1000 shells; they show approximately the maximum range of variation.

[9] Pilsbry, Man. Conch., Vol. XIV, pl. 52, fig. 28.

6. **Bulimulus chamberlini** Hanna, new species

Plate 8, figure 21

Shell very small; whorls flattened with suture lightly impressed; pale flesh color, marked only with fine thread like lines of growth; no spiral sculpture visible on type specimen under moderate magnification; umbilicus rimate; aperture ovate; peristome expanded on all sides but not revolute; the terminations approaching and connected across by a thin wash of callus; axis armed internally with a roundly triangular tooth in the usual position of the denticle in the group Sonorina. Altitude of imperfect type, 15.8 mm.; original altitude about 20 mm.; diameter, 9.2 mm.; altitude of aperture, 9.2 mm.

Type: No. 1023; Mus. Calif. Acad. Sci., collected May 27, 1921, by Joseph C. Chamberlin, on **San Diego Island, Gulf of California.**

This species is more closely related to *B. dentifer* than any other. It is still smaller than the smallest examples of that species; the outer termination of the peristome is more nearly vertically above the columellar termination; the peristome is not revolute; and the axial tooth is shaped as in *B. veseyianus* as figured by Pilsbry[11] while in *dentifer* it is square and sinuous on the outer edge similar to *lamellifer.*

Usually it is unsafe to describe a species from one imperfect specimen but in this case the essential characters are all well preserved and so distinct from any known form that the action seems justified.

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[10] Nautilus, Vol. IX, 1895, p. 83.

[11] Man. Conch., Vol. XI, pl. 21, fig. 93.

The species is named for Mr. Joseph C. Chamberlin of the 1921 Expedition, who collected the type specimen.

7. Bulimulus rimatus (Pfeiffer)

Bulimulus rimatus (Pfeiffer), Pilsbry, Man. Conch., Vol. XI, 1897-98, p. 157, pl. 21, figs. 1-4.

Bulimulus bryanti Cooper, Proc. Calif. Acad. Sci., 2nd Ser., Vol. 3, 1893, pp. 101, 340, pl. 13, figs. 4 a-c.

This species was not collected by the members of the 1921 Expedition because they did not visit its habitat in the Cape Region. But Joseph R. Slevin collected two excellent specimens alive (No. 18,366, C.A.S. Coll.) at Rancho Guamuchil, near Todos Santos (Cape Region) August 7, 1919. They were found at an elevation of 1000 feet in cracks between boulders beside a creek bed.

Pilsbry has placed the species described by Cooper as *bryanti* in the synonymy of *rimatus* and a careful reading of the original descriptions has convinced me that this action was justified.

8. Bulimulus lamellifer Pilsbry

Bulimulus lamellifer Pilsbry, Nautilus, Vol. 10, 1897, p. 103.—Pilsbry, Manual Conch., Vol. XI, 2nd Ser., 1897-8, p. 160, pl. 21, figs. 94-99.

The type locality of this species is given as "Lower California, probably on the Gulf side between San Antonio and San Borja."

Numerous specimens were obtained by the Academy Expedition from the following localities: Coyote Bay, Concepcion Bay, No. 22862, E. P. Van Duzee, Coll., 7 specimens; back of Agua Verde Bay, No. 22844, I. M. Johnston, Coll., 12 specimens; and Canyon west of Puerto Escondido, No. 22961, Joseph Chamberlin and I. M. Johnston, Colls., 40 specimens; Danzante Island, No. 22843, Fred Baker, Coll., 47 specimens.

The species belongs to the group, Sonorina Pilsbry, and is characterized chiefly by a "very high, thin, square or emarginate, erect plate", on the columella; this is similar to *B. dentifer* of Tortuga Island, but that is a much smaller form of the same group. The peristome of *lamellifer* is broadly reflected and there is considerable variation in size in a large series of shells. Measurements of 24 specimens selected at random are as follows in millimeters:

Measurements in millimeters

Cat. No.	Altitude	Diameter	Altitude of aperture
22961	33.5	14.9	15.3
	32.4	14.	14.5
	33.	16.5	15.5
	34.7	16.	16.4
	30.3	15.2	15.1
22862	31.4	15.3	15.8
	28.3	14.7	13.9
	28.3	14.9	14.3
	30.5	14.9	14.
22844	28.	13.5	13.2
	30.	13.2	13.9
	28.6	12.3	13.3
	28.5	13.	13.1
	27.6	14.2	13.5
22843	32.6	17.	15.9
	31.1	16.3	15.9
	32.1	16.8	16.4
	32.3	15.5	15.5
	33.2	16.5	16.9
	26.8	14.3	14.3
	27.6	14.	14.5
	31.	15.8	15.
	30.	15.7	15.5
	29.5	15.	15.

It will be noted from the foregoing that the series from Escondido Bay averages largest and that from Agua Verde Bay smallest. But the intergradation demonstrates that we are dealing with but one species in so far as these characters are concerned. The series from Danzante Island has a slightly longer aperture than the others when an average is taken but the difference is so slight and the intergradation so perfect that separation seems unwarranted.

When alive and fresh the shells are of a light, flesh-brown color and possess an "oily-gloss" on the surface; this is lost in weathered specimens to a large extent. The faint spiral striation mentioned by Pilsbry is evident on fresh shells but is lost to a considerable degree after they have become chalky.

The species resembles *B. spirifer* (Gabb) in shape, sculpture, and glossiness, but the peristome of that form is not so broadly reflected and revolute; moreover, the internal plait is a "corkscrew" thread on the axis in *spirifer* not a high, square denticle as in *lamellifer* and *dentifer*.

The very indefinite type locality of *lamellifer* is confusing. It is doubtful if it came from anywhere near San Borje back of Los Angeles Bay or San Antonio in the Cape Region. Gabb traversed the length of the Peninsula and it seems almost certain that he secured this species somewhere near the center. All three of the Academy localities are about midway between the two above mentioned, and since the party failed to find *B. spirifer* it seems almost equally certain that it is to be found only in the Cape Region, perhaps as far north as La Paz. The localities, near San Borja, San Jose on the Gulf and Tres Virgines near Santa Rosalia given by Pilsbry are questionable.

9. **Bulimulus ximenez** Hanna, new species

Plate 8, figures 4-9

Shell heavy, robust, whorls 6¼ to 7, light vinaceous flesh-color when alive; outer wall dark brown inside of aperture; growth lines rough and irregular; surface slightly glossy when alive, chalky white if long dead; peristome strongly reflected and revolute, the upper terminations approximating and connected across the body whorl by a heavy callus; whorls rounded and last one expanded greatly in its lower portion as the aperture is approached; back one-third whorl from the aperture, the axis is armed with a vertical plait or denticle; this is square in shape, slightly emarginate or sinuous on its outer edge; sometimes a considerable portion is visible from the aperture but more often only a columellar fold can be seen without breaking the shell behind; nucleus composed of two costulate whorls; spiral striation almost invisible on the type but in other specimens of the same lot it is seen to be present but very fine and regular.

Type: No. 1042; paratypes, Nos. 1043-1047; Mus. Calif. Acad. Sci., collected at **Marquer Bay, Carmen Island, Gulf of California,** by Fred Baker, J. C. Chamberlin, V. Owen, J. R.

Slevin and E. P. Van Duzee. The type lot, No. 22,965, consists of 163 specimens.

Measurements in millimeters

Altitude	Diameter	Altitude of aperture
34.3	18.2	19.
38.	18.2	19.9
41.	20.	19.7
34.	17.7	19.5
32.8	16.2	16.
30.7	16.6	17.
31.2	15.	15.5
33.7	17.	17.
37.8	20.7	21.2
36.	18.5	19.
32.4	18.3	18.4
33.1	19.	18.6
32.1	18.3	18.
33.7	17.2	17.6
31.1	16.	16.7
28.8	15.6	15.8
30.	17.	17.

Specimens examined

Catalogue No.	Locality	Collector	Number of specimens
22855	Agua Grande, Carmen I.	Fred Baker	4
22860	Salt Works, Carmen I.	V. Owen J. C. Chamberlin	60
22872	Coronados Island	J. C. Chamberlin J. R. Slevin Fred Baker I. M. Johnston	77
22963	South side main canyon, Carmen Island	Fred Baker	65
22966	North side main canyon, Carmen Island	Fred Baker	6
22965	Marquer Bay, Carmen I.	Fred Baker J. C. Chamberlin I. M. Johnston Virgil Owen J. R. Slevin E. P. Van Duzee	163
22967	South canyon near Yellow Bluff, Carmen I.	Fred Baker	19

This species belongs to the group, Sonorina; it has the heavy, broadly reflected, peristome of *B. veseyianus*, but not the triangular denticle of that species. It has the huge, quadrate, emarginate denticle of *B. lamellifer* and *B. dentifer* but a much more expanded basal aperture than any of the species mentioned. The subspecies, *B. spirifer orthclasmus* Pilsbry[12] has not been figured and was described without definite locality. The specimen had a high straight denticle, not sinuous or emarginate as in *lamellifer* or corkscrew shaped as in *spirifer*. The costæ on the nepionic whorls are developed in the same manner as in the other species of the group but they are less strongly marked; except for their regularity they are no more evident than the growth ridges lower on the shell.

From the measurements it will be seen that the smallest specimens came from Coronados Island. Intergradation occurs, however, in these as well as other characters.

It seems rather remarkable that this species of Carmen and Coronados islands should be most closely related to the form found on Espiritu Santo Island and not to that of the adjacent mainland and Danzante Island close by.

The species is named for Fortun Ximenez, pilot and in command of the ship *Concepcion*, which, sailing under orders from Cortez, discovered Lower California at La Paz Bay in 1834.[13]

10. Bulimulus veseyianus Dall

Plate 8, figures 1-3

Bulimulus (Leptobyrsus) veseyianus Dall, Proc. U. S. Nat. Mus., Vol. 16, 1893, p. 645, pl. 71, figs. 4, 5. Type locality, Espiritu Santo Island, Gulf of California, Lyman Belding, coll.—Pilsbry, Man. Conch., 2nd Ser., Vol. XI, 1897-98, p. 160, pl. 21, figs. 92-93.

The Academy Expedition of 1921 collected three lots of this species on Espiritu Santo Island: No. 22841, first anchorage North Island, five specimens, Virgil Owen, coll.; No. 22842, El Candelero, 13 specimens, I. M. Johnston, coll.; No. 22839 north end section of island, 5 specimens, I. M. Johnston, coll.

The species was founded upon and has heretofore been known from the five original specimens collected by Belding about 1883. The following measurements will aid further in making the species recognizable.

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[12] Man. Conch. 2nd. Ser., Vol. XI, 1897-8, p. 159.

[13] The account may be found in Resources of the Pacific Slope, 1869, by J. Ross Browne, appendix p. 15. Ximenez had murdered his captain, Becarra, and was in turn killed with twenty of his crew by natives at La Paz. The following year the place was visited by Cortez, urged on by the beautiful pearls brought back by the crew of the *Concepcion*.

Measurements in millimeters

Altitude	Diameter	Altitude of aperture	Cat. No.
41.	21.	20.	22841
37.3	19.8	19.3	
37.6	20.3	21.	
36.5	20.4	19.9	
41.7	22.4	21.5	22839
38.8	18.	17.7	
40.2	20.	20.3	22842
40.6	20.9	21.4	
41.	21.2	21.2	

This species has a corkscrew like lamella on the axis as in *B. spirifer* but is larger than that form and has the greatly expanded aperture and reflexed peristome of *B. ximenez.* The lamella extends back three-fourths of a whorl and at its upper end it is projected outward into a linguiform denticle as shown herewith and in the original figure. The development of this denticle is somewhat dependent upon age, younger individuals having the lamella projected no more than in *B. spirifer.*

11. **Bulimulus bakeri** Hanna, new species

Plate 7, figures 7-10

Shell of medium size, slightly glossy, light flesh brown in color somewhat streaked with a lighter color parallel to growth lines; whorls almost 7 (in type) slightly rounded to the apex; nucleus composed of two costulate whorls as usual in the group; umbilicus rimate; aperture ovate with broadly expanded peristome all around; terminations closely approximated; peristome slightly revolute on outer margin; axis thickened and with two long low blunt denticles in the same position as the blade like lamella of *lamellifer;* just back of the aperture the sculpture consists of irregular growth lines crossed by regular, microscopic, incised lines; these become weaker toward the upper whorls of the shell.

Type: No. 1017; paratypes, Nos. 1018-1020; Mus. Calif. Acad. Sci., collected in 1921 by Virgil Owen at **San Antonio**

Point, San Nicolas Bay, Lower California. The type lot consists of eight specimens.

Measurements in millimeters

Altitude	Diameter	Altitude of aperture
35.6	16.8	16. (Type)
32.8	15.	14.5
34.1	15.5	14.8
31.5	15.5	14.1
31.2	14.6	13.5

Named for Dr. Fred Baker, conchologist of the Expedition.

The species seems to be more closely related to *B. spirifer* in external characters than any other. But the greatly reduced size of the armature of the axis distinguishes it from any other form and gives it an intermediate position between the group of *B. inscendens* and Sonorina. The peristome is not so broadly reflected as in *B. lamellifer,* also a peninsular form.

In this connection attention is called to the fact that the members of the 1921 Expedition failed to find *B. spirifer* Gabb. In characteristic manner Gabb gave the locality of his species as, "...............the mountains, among rocks from San Antonio below La Paz to near San Borja and in the highest mountains perhaps even farther north."[14]

In 1867 he made a trip on horseback from Cape San Lucas to San Diego, crossing the peninsula ten times before completing the journey. Thus he visited most of the important settlements on both sides, as well as the interior missions. His itinerary is given fully with a great deal of other information on the geology and conditions encountered in "Resources of the Pacific Slope" by J. Ross Browne, D. Appleton & Co., New York, 1869. In this he did not mention Bulimulus collections so it is probably impossible ever to determine the type locality of his *spirifer* exactly, but it quite evidently does not come down to the east coast regularly. On the other hand, it is equally doubtful if, in the mountains, it occupies anything like the extensive range the author gave it. The San Antonio mines and San Borje are about 600 miles apart.

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[14] Amer. Journal Conch., Vol. III, p. 236, pl. 16, fig. 5, 1867.

Section **Plicolumna** Cooper

The three species of this group are confined to the Cape Region and hence were not encountered by the 1921 Expedition. They are *artemesia, abbreviatus* and *ramentosus,* and are well described and figured by Pilsbry.[15]

Group of **B. inscendens**

In order to complete the review of the Lower California bulimuli the species of this group will be listed. Additions and emendations have not been made since the appearance of Pilsbry's monograph in 1897-98.[16]

The following list shows the names which have been referred to the group, synonyms or unrecognizable species being in italics:

B. inscendens (Binney)
B. xantusi (Binney)
B. beldingi Cooper
B. alta Dall
B. monticola Dall
B. cacotycus Mabille
B. digueti Mabille

The subspecies *alta* and *monticola* are of doubtful taxonomic value; they appear to represent variations rather than biological units; only one of them can stand at best. The names of Mabille can only be validated by a re-examination of his material; otherwise they are worse than *nomen nuda.* Eliminating these leaves three valid species of the group, *inscendens, xantusi,* and *beldingi* with the possibility of *alta* being added to the list. All are confined to the Cape Region and hence were without the territory examined by the 1921 Expedition.

Genus **Micrarionta** Ancey, 1880

The type of this group of helicies is *Helix facta* of certain of the Santa Barbara Islands off the coast of California. It has been divided into three sections as follows: Micrarionta s. s.; Eremarionta Pilsbry; and Xerarionta Pilsbry. The second group consists of species of the desert regions of California, Arizona and Lower California and the shells greatly resemble those of the genus Sonorella. The species of the third group are large and globose as a rule and are confined chiefly to the islands off the coast of California and Lower California, although a few have been taken on neighboring shores of the mainland and peninsula. In considering results of the 1921 Expedition it is necessary to treat only one species of each of the last two groups, the first not being found in the region covered.

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[15] Man. Conch., 2nd Ser., Vol. XI, 1897-98, pp. 151-154.

[16] Man. Conch., 2nd Ser., Vol. XI., 1897-98, pp. 148-151.

12. **Micrarionta peninsularis** (Pilsbry)[17]

Plate 8, figures 14, 15; plate 11, figure 1

Sonorella peninsularis Pilsbry, Nautilus, Vol. 29, 1916, p. 100, pl. 2, fig. 4.

This species was described from specimens collected by Gabb in 1867 on his memorable journey overland from Cape San Lucas to San Diego. He gave the locality as "Trinidad on the west coast near San Borga." The mission San Borje is 18 miles west of the Gulf Coast at Angeles Bay. Pilsbry was unable to locate "Trinidad" on available maps and it is not given on the latest and most complete one I have seen, made by E. W. Nelson and published in 1921.[18] The locality should not be confounded with the well known Trinidad Valley just to the north of the San Pedro Martir Mountains and opposite San Felipe Bay, 160 miles north of Angeles Bay. Nelson has given a description of that valley in his memoir.[19]

The location of Gabb's "Trinidad" is minutely described by him in the narrative of his journey, published in 1869.[20] It is a deep canyon with a spring, on the west side of the peninsular divide. The party camped at the spring while examining prospective copper properties within a day's journey of the place. It is about 20 miles ("7 leagues") south of Rosarito (see Nelson's map) which would be the arroyo now known as "San Luis." This heads in the Sierra de Calmalli. Thus the type locality of the species appears to be approximately 30 miles south of San Borje.

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[17] The Helicies of Lower California are fully treated in the following publications: Bartsch, Smith. Misc. Coll. Vol. 47, 1904, pp. 187-200—Pilsbry, Proc. Acad. Nat. Sci. Phila. 1913, pp. 380-393.—Pilsbry, Nautilus, 1916, Vol. 29, pp. 97-102.—Berry, Proc. Acad. Nat. Sci. Phila. 1922, pp. 69-100.

[18] Mem. Nat. Acad. Sci., Vol. 16.

[19] Op. Cit. pp. 16, 18, 19, 76.

[20] J. Ross Browne, Resources of the Pacific Slope, 1869, pp. 105-107 of Appendix. D. Appleton & Co., New York. A second edition seems to have been issued in 1887 but I have not seen it.

A "Trinidad Point" is indicated on some maps just south of San Carlos Bay on the Gulf Coast of the peninsula but has nothing to do with Gabb's locality.

Micrarionta merrilli (Bartsch)[21] was described with the type locality given indefinitely as "Below San Quintin, Lower California." I have made no attempt in this connection to trace the locality further because the species is obviously distinct from the one with which we are dealing.

Mr. Johnston of the 1921 Expedition took two weathered shells of what appears to be *M. peninsularis* two miles back of Angeles Bay. It is not known if they were in a position which would indicate that they had been washed from the mountains farther west but the sand inside the apertures shows conclusively that they had been carried by water for some distance. It seems probable that the species occupies the region of the divide west of Angeles Bay, and empty shells might float toward either coast when streams are swollen.

The largest and best preserved specimen is 19.6 mm. in diameter; 13 mm. in altitude and the umbilicus is 2.3 mm. in diameter. In shape it agrees almost exactly with Pilsbry's figures. The apex is figured herewith. The wavy rugosity seems to extend farther down on the nuclear whorls than the author of the species described, but this is not certain. The nuclear characters seem to show a closer relationship with *M. fisheri* (Bartsch) from Death Valley, California, than with such as *M. orcutti* (Bartsch) from Mountain Springs, San Diego County, California.

All of the Sonorella-like helicies from west of the Arizona-California boundary have been found to belong to the genus Micrarionta when the anatomy has been investigated. It therefore seems reasonable to infer that the same is true of them all.[22]

A fragment of another species of the same section of the genus was obtained at Puerto Refugio, Angel de la Guarda Island, by the 1921 Expedition. It is smaller than *M. peninsularis* and has a much wider umbilicus but is too imperfectly represented for specific description.

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[21] Sonorella merrilli Bartsch, Smith, Misc. Coll., Vol. 47, 1904, p. 192, pl. 32, fig. 5.

[22] See Berry, Proc. Acad. Nat. Sci. Phila. 1922, p. 86, for a discussion of this subject.

13. **Micrarionta exanimata** (Cooper)

Plate 8, figures 11-13

H. (elix) areolata var. *exanimata* Cooper, Proc. Calif. Acad. Sci., 2nd Ser., Vol. 3, July 15, 1893, p. 216, pl. 14, fig. 7.

(Micrarionta areolata) var. *exanimata* (Cooper), Pilsbry, Proc. Acad. Nat. Sci. Phila. 1913, p. 393.

This form was described from 38 subfossil specimens collected on Espiritu Santo Island by Mr. W. E. Bryant of the California Academy of Sciences in 1892 but was not found there by the members of the 1921 Expedition. On Monserrate Island, however, Mr. E. P. Van Duzee collected seven specimens which agree sufficiently with Cooper's description to be referred thereto. The description is so poor it is scarcely recognizable, and the figures are worse, but both lots of material were subfossil and are believed to be the remains of a now extinct species which formerly inhabited a larger land mass than now exists off shore in the region. The Monserrate Island specimens are certainly specifically distinct from *M. areolata* as that species is found about Magdalena Bay on the west coast of the peninsula. They are much more nearly like the form of *M. levis* with the heavy columellar tooth found on Natividad Island specimens. No trace of a former system of bands could be detected in the Monserrate specimens.

14. **Thysanophora hornii** (Gabb)

Single specimens of what appear to be this species were collected by the members of the 1921 Expedition at three places in the Gulf of California region: Agua Verde Bay, L. C.; Carmen Island; and Monserrate Island. The one from the first mentiond place is the largest, being 3.5 mm. in diameter; it has 3.75 whorls and the last two are hirsute. The specimen from Monserrate Island is young, glassy transparent instead of brown and may belong to a different species, but in shape and size it corresponds to an equivalent portion of the largest specimen.

15. **Berendtia taylori** (Pfeiffer)

Plate 8, figure 10

Clausilia (Balea?) taylori PFEIFFER, Proc. Zool. Soc. London, 1861, p. 27, pl. 2, fig. 7.—CROSS & FISHER, Miss. Scient. au Mex., Moll., Vol. 1, p. 304, pl. 14, fig. 1, pl. 16, figs. 1-4 (Shell and anatomy).

Berendtia taylori, PILSBRY, Man. Conch., Vol. 15, 1903, 2nd Ser., pp. 57-58, pl. 18, figs. 30-36.

Cylindrella (Urocoptis) newcombiana GABB, Amer. Journ. Conch., Vol. 3, 1867, p. 237, pl. 16, fig. 3.

While working in a canyon back of Puerto Escondido, Lower California, Messrs. I. M. Johnston and J. C. Chamberlin came across this strange species and collected 46 specimens. The locality from which the original specimen came was unknown and to this date the species has been known chiefly through specimens collected in the mountains west of Mulegé by Gabb in 1867 and which he described as a new species.

Genus **Cœlocentrum** Cross & Fisher

The type species of this genus is *C. turris* Pfeiffer[23] of southeastern Mexico. Most of the species live in Mexico or Central America but a group, somewhat aberrant, is found in Lower California; this has received the subgeneric name Spartocentrum,[24] with *C. irregulare* Gabb as type. Mabille[25] also gave the group a name, Teneritia with the unrecognizable species, *Berendtia digueti* and *B. minorina* as types.

The name Spartocentrum will probably eventually be given generic rank. Up to the date of this report five species have been described from the region. The members of the 1921 Academy Expedition obtained many hundreds of specimens at various localities and in identifying them it has been necessary to review those previously known. The complete list is as follows; synonyms or unrecognizable forms being in italics:

C. irregulare (Gabb)
C. gabbi Pilsbry
C. eisenianum Pilsbry
C. digueti (Mabille)
C. minorinum (Mabille)
C. eiseni Bartsch

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[23] Pilsbry, Man. Conch., 2nd Ser., Vol. XV, 1903, p. 37, pl. 12, figs. 1-4.

[24] Dall, Nautilus, Vol. IX, 1895, p. 51.

[25] Bull. de la Soc. Philomathique de Paris, 8th Ser. Vol. IX, 1896-97, p. 79.

The first species was collected by Gabb in 1867 in the mountains back of Mulegé near the east coast of the peninsula halfway down. He described it soon after his return.[26] He must have collected a very considerable number of specimens because the original lot has been widely distributed. Some went to Dr. Wesley Newcomb, who, in turn, gave them to his friend Henry Hemphill. These now form part of the Academy Collection.

Mabille in 1896-97 described two new species in a slipshod manner, *digueti* and *minorina,* neither of which was figured or compared with other species. They are absolutely unrecognizable without access to his original collection.

A monograph of the group by Pilsbry appeared in 1903.[27] He described a new species *C. eisenianum* from Cape San Lucas.[28]

Through lack of sufficient comparative material he described a new subspecies, *gabbi,* from Gabb's original material and attached it to *minorinum.* The separation from *irregulare* was based chiefly upon the shape and free extension of the aperture. The type of *irregulare* has the aperture appressed to the body whorl and thus becomes horizontal, or almost so, on top. But the type of *gabbi* has the aperture at the end of a free extension of the body whorl and is correspondingly changed in shape, due probably to the manner in which the shell is carried by the animal before growth is completed. With a very large amount of material before me with colonies kept separated, the extension of the aperture is found to be of no importance as a taxonomic character in this group. The photographs of a series of specimens from Carmen Island illustrate this fact. The other characters mentioned to differentiate *gabbi* from *irregulare* are of minor importance and are completely bridged in a series of specimens from one colony. The difference in number of ribs on the penultimate whorl is given as only four.

This leaves but two recognizable species in the group, *irregulare* and *eisenianum.* To these are added herein:

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[26] Amer. Journal Conch., Vol. III, 1868, p. 238, pl. 16, fig. 4 as Cylindrella (Urocoptis) irregularis.

[27] Man. Conch., 2nd Ser., Vol. 15, 1903, pp. 51-57.

[28] See Bartsch, Proc. U. S. Nat. Mus., Vol. 31, 1907, p. 119, for full type locality. The specific name is there misquoted "C. eiseni." Pilsbry gave only "Lower California" as a locality in the original description.

C. vanduzeei	C. clavigeroi
C. oweni	C. insulare

16. Cœlocentrum irregulare (Gabb)

Plate 9, figures 1, 2

Cylindrella (Urocoptis) irregularis Gabb, Amer. Journ. Conch., Vol. III, p. 238, pl. 16, fig. 4, 1868.—Pilsbry, Proc. Acad. Nat. Sci. Phila. 1900, pp. 553, 554, figs. 3, 4.

Cœlocentrum irregulare, Pilsbry, Man. Conch., 2nd Ser., Vol. XV, 1903, p. 51, pl. 13, figs. 15, 16; pl. 17, fig. 24.

Cœlocentrum minorinum gabbi Pilsbry, Proc. Acad. Nat. Sci. Phila. 1900, p. 551.—Pilsbry, Man. Conch., 2nd Ser., Vol. XV, 1903, p. 54, pl. 13, figs. 17-19.

This species was originally described from collections made by Gabb in 1867 in the "high mountains back of Mulegé", Lower California. It was not found by the members of the 1921 Expedition but the Academy is fortunate in possessing two specimens from the original collection which are figured herewith.

The species is imperforate; the axis is narrow and shaped like a round bar which has been twisted slightly off center.

17. Cœlocentrum vanduzeei Hanna, new species

Plate 9, figures 31-34; plate 11, figure 7

Shell larger than *C. irregulare,* bullet-shaped, composed of 17 rounded whorls; suture deeply impressed; first three whorls of almost equal diameter, the third being slightly less than the one above; from the third to the fourteenth the diameter increases slightly, then decreases to the last; all whorls sculptured with coarse ribbing except the third; this one only has the vertical ribs cut by about nine deep spiral grooves, making the surface beaded; penultimate whorl with 86 ribs; aperture straight above, slightly oblique, and expanded; peristome continuous and sharp; columellar wall with a rounded ridge bounded by a rounded groove in lower basal angle; last 3.2 mm. of last whorl free from one preceding; umbilicus perforate, the opening about .5 mm. in diameter; axis hollow throughout, the opening in center of shell being two mm. in diameter; a heavy spiral cord is centrally located on the axis of each whorl; below and above are concave excavations; this cord forms an external rounded ridge bounding the umbilical depression.

Type: No. 1085; paratypes, Nos. 1086-1088; Mus. Calif. Acad. Sci., collected by Edward P. Van Duzee June 14, 1921, on the west side of **Puerto Escondido, Lower California.**

Measurements in millimeters

Altitude	Diameter of penultimate whorl	Greatest diameter exclusive of projecting aperture.
24.9	5.5	5.6 (Type)
24.8	5.7	5.9 (Paratype)
24.4	5.6	5.6 (Paratype)

The species is distinct from *C. irregulare* by its slightly greater length, and decidedly greater diameter, both of shell and axis. Moreover, the internal spiral cord is very much heavier than in *C. irregulare.* In fact no close relative of the new species has been seen. The above is a description of the type specimen.

The series collected shows very little range in size but in shape of aperture it is great as shown in the figured paratypes. These offer conclusive proof that the projection of the free portion of the aperture is a character of individual variation only. If it were considered of specific value it would be necessary to describe every specimen in the lot as new. The shape of the aperture varies in accordance with the length of the free portion.

Named for Mr. Edward P. Van Duzee, curator of Entomology in the museum of the California Academy of Sciences, and a member of the Expedition.

18. **Cœlocentrum insulare** Hanna, new species

Plate 9, figures 9-28; plate 11, figure 5

Shell, similar in shape to *C. oweni* but much more variable; type a shell of average size and shape, a little more slender than the above mentioned species; umbilicus of about the same diameter, but axis narrower and spiral cord less developed and less rounded in cross section; whorls 14½ in type but only 11½ in a paratype; all intergradations between are found in the type lot; last half of second whorl and all of third with the ribs crossed by heavy spiral channels; below this area the interspaces for three whorls are crossed by about five spiral riblets; the first and second whorls are densely, minutely, spirally striate in the intercostal spaces; this is a character more or less developed in *C. oweni* but is more pronounced in *C. insulare;* it is best displayed in weathered specimens.

Type: No. 1061; paratypes, Nos. 1062-1081; Mus. Calif. Acad. Sci., collected May 21, 1921, by Fred Baker and Virgil Owen at **Puerto Bellandra, Carmen Island, Gulf of California.** The type lot consists of over 500 specimens.

Measurements in millimeters

Altitude	Diameter exclusive of apertural projection	
16.6	3.8	(Type)
15.7	3.9	Paratypes
17.6	3.7	
16.8	3.5	
14.5	3.5	
16.9	3.4	
13.5	3.8	
14.8	4.0	
13.4	4.0	

In contrast with *C. oweni* this species shows great individual variation as the above table of measurements portrays. In no case is the diameter as great as in *C. oweni,* therefore, there is no intergradation and the one is evidently not a subspecies of the other. The narrow axis is a constant character. Also the apical characters and the spiral intercostal riblets are likewise; these are best displayed on weathered shells. It may be suggested that the relative stability of the characters in *C. oweni* is due to the habitat being in proximity to greater moisture, while the Puerto Bellandra colonies are in an excessively dry and hot location.

In addition to the type lot 23 specimens collected by E. P. Van Duzee and J. C. Chamberlin at Marquer Bay, Carmen Island, have been referred to this species.

A careful examination failed to disclose any reasonably constant character whereby the specimens from Santa Catalina

Island could be separated from those from Puerto Bellandra, Carmen Island. With a large series of over 200 specimens, from the former place it is noted that the same great variation in number of whorls and altitude is displayed. Apical characters, sculpture and shape of axis are practically identical. The following are measurements of Santa Catalina Island specimens:

Measurements in millimeters

Altitude	Diameter exclusive of projecting aperture	
15.6	3.9	Paratypes
17.5	4.0	
15.9	3.9	
17.8	3.6	
14.2	4.0	
13.7	4.0	

A series of Santa Catalina specimens is figured herewith (pl. 9, figs. 18-24) to demonstrate their identity with those from Carmen Island.

The same remarks apply to a series of specimens taken by Mr. Chamberlin on Monserrate Island, and 66 specimens taken on Danzante Island by Dr. Baker and Mr. Johnston. No constant shell characters could be found to distinguish them from the type lot. Two from each island are figured herewith (pl. 9, figs. 25, 26 and 27, 28) to demonstrate the similarity.

It seems very remarkable that a species of this family, so prone to colonization, should have so wide a range among the Gulf islands. Such similarity was not displayed among the bulimuli.

19. **Cœlocentrum oweni** Hanna, new species

Plate 9, figures 3-8; plate 11, figure 8

Shell small, short conical, composed of 14 rounded whorls; suture deeply impressed; all whorls coarsely sculptured with vertical ribs, the first half of the third whorl having in addition about 10 weak spiral channels crossing the ribs; the last three whorls almost equal in size but those above taper to the blunt apex with the first three again almost of equal diameter; penultimate whorl with 59 ribs; spaces between sometimes rounded, again V-shaped and sometimes flatbottomed; (this however is true of all species of the group which have been studied); aperture almost circular, expanded, at the end of a free extension of the last whorl 2mm. long; parietal and columellar margins meeting at an obtuse angle inside, the latter with a faint trace of a plication at the base, the end of the axial cord; umbilicus .5 mm. in diameter; axis perforated to the apex; in the center of the shell the hole is no larger than the umbilicus; axis with a rounded spiral cord which slopes to the septum both above and below in straight lines until the latter is almost reached, when there is a concavity.

Type: No. 1055; paratypes, Nos. 1056-1060; Mus. Calif. Acad. Sci., collected by Virgil Owen June 15, 1921, in the canyon back of **Agua Grande, Carmen Island, Gulf of California.** The type lot consists of 86 specimens collected under a single stone.

Measurements in millimeters

Altitude	Diameter exclusive of apertural projection
17.2	4.3 (Type)
16.9	4.3 (Paratype)
16.2	4.2 "
17.3	4.2 "
17.1	4.2 "
16.5	4.4 "

The above description of external shell characters is derived from the type specimen, and internal characters from the figured paratype. In the type lot but little variation is found except in the distance of the free projecting portion of the last whorl. This is illustrated in the figures. *C. insulare* differs in the narrower axis and in apical characters.

Named for Mr. Virgil Owen, a member of the Expedition.

20. **Cœlocentrum clavigeroi** Hanna, new species

Plate 9, figures 29, 30; plate 11, figure 6

Shell of medium size similar to *C. irregulare;* slender, consisting of 19 rounded whorls; first four and a half of approximately equal diameter; also the last six are about equal in diameter, giving the shell a cylindrical appearance, as in *irregulare;* all whorls sculptured with axial ribs, those of the third whorl being crossed by 10 spiral channels producing a beaded sculpture; penultimate whorl with 60 axial ribs; umbilicus very narrowly perforate, the opening increasing in diameter toward the center of the axis; aperture angular, free from preceding whorl; no evidence of axial plication at basal angle; axis armed with a heavy square cord which in the lower whorls has a groove in the center.

Type: No. 1082; paratypes, Nos. 1083-1084; Mus. Calif. Acad. Sci., collected May 26, 1921, by I. M. Johnston at **Agua Verde Bay, Lower California.** The type lot consists of 12 specimens, mostly imperfect.

Measurements in millimeters

Altitude	Diameter exclusive of projecting aperture
25.3	4.5 (Type)
23.5	4.4

This species resembles *C. irregulare* externally. The perforate umbilicus and heavy, square axial cord distinguish it. The species is named for Francisco Javier Clavigero, who published a valuable history of Lower California in Italian in 1789.

Genus **Pupoides** Pfeiffer

One of the most remarkable discoveries in land shell distribution made by the members of the 1921 Expedition was the finding of this genus on many of the Gulf of California islands. The affinities of the species are with Arizona forms and not with the one which has been found on the mainland of Mexico at Mazatlan, *P. chordatus.* This would indicate that the distribution is in some way connected with the currents from the Colorado River. But if so, why were not larger species similarly affected? Their course of migration has been directly opposite.

21. Pupoides marginatus (Say)

Cyclostoma marginata SAY, Journ. Acad. Nat. Sci. Phila., Vol. II, 1821, p. 172.—*Pupoides marginatus* (SAY), PILSBRY & VANATTA, Proc. Acad. Nat. Sci. Phila. 1900, p. 586.—PILSBRY, Man. Conch., 2nd Ser., Vol. 26, No. 102, p. 111, 1921; (full bibliography given and monograph of the genus).

This species was found in small numbers on several of the islands of the Gulf of California. The records are as follows:

Locality	Number of specimens
Angel de la Guarda Island	1
Tortuga Island	17
San Lorenzo Island	6
San Esteban Island	16
Monserrate Island	3

These specimens cannot be distinguished from the species as it occurs in Arizona. Regarding these, Pilsbry remarked: "In Arizona the shell is often small and delicate, length 4mm., hardly over 5 whorls, with scarcely any callous pad in the angle of the mouth, thus resembling *P. modicus;* but in the same lots there are also larger shells." The island specimens bear no resemblance to *P. chordatus,* described from Mazatlan, and they are likewise constantly distinguishable from the form found on Santa Catalina Island.

22. Pupoides catalinensis Hanna, new species

Plate 10, figures 1-4

Shell similar to *P. marginatus* but more slender and cylindrical; whorls five, rounded, suture deeply impressed; epidermis roughened parallel to growth lines, so the species is without gloss; growth lines fairly regular with an occasional white streak parallel to them; umbilicus rimate; peristome broadly reflected, thickened within and almost complete across the body whorl; no indentation of the aperture on the upper palatal wall.

Type: No. 1090; paratypes, Nos. 1091-1093; Mus. Calif. Acad. Sci., collected by J. C. Chamberlin on **Santa Catalina Island, Gulf of California.** The type lot consists of 82 specimens.

Measurements in millimeters

Altitude	Diameter
4.5	1.9 (Type)
4.3	1.7
4.0	1.5
3.8	1.6

This species has the shape of *P. hordaceus* (Gabb) but lacks the characteristic rib sculpture of that form. While the specimens of *Pupoides* from all of the other Gulf islands are clearly *marginatus* and agree with that species in size, shape and sculpture, this one on Santa Catalina Island is constantly different. There does not seem to be a tendency toward intergradation. There is some variation in altitude but the shape still remains more cylindrical than in *marginatus.*

23. **Gastrocopta pellucida parvidens** (Sterki)

Bif. (idaria) hordeacella Pils. var. *parvidens* Sterki, Nautilus, Vol. XII, 1899, p. 128.—Pilsbry & Vanatta, Proc. Acad. Nat. Sci. Phila. 1900, p. 594, pl. 22, fig. 2.—Pilsbry, Man. Conch., 2nd Ser., Vol. 24, p. 80, pl. 17, fig. 8.

This form was described from Jerome, Arizona, and has been found elsewhere in that state. It is characterized by a reduction in the size of the apertural teeth and the absence of a basal. Eight specimens were collected by the members of the 1921 Expedition on the volcanic island of Tortuga in the center of the Gulf of California. These are thin and delicate, very light horn-color or translucent white; they agree in every way with the figure given by Pilsbry except for a slightly greater development and bifurcation of the parietal tooth. This difference seems too small to recognize specifically since it is a more or less variable character in all species of the genus.

24. **Gastrocopta rixfordi** Hanna, new species

Plate 10, figures 5-8

Shell minute, cylindric; whorls four, rounded; glassy transparent when alive; lines of growth very fine but evenly spaced; last whorl with an expanded bulge just back of the aperture; aperture semielliptical; peristome broadly reflected but not thickened with callus; ends continuous across the body whorl;

apertural armature consisting of five or six teeth depending upon the degree of separation of the parietal (type specimen has five); upper and lower palatal very deeply seated, flat and blade-like, the latter being the larger and deeper placed; basal thin, quadrangular, the axis placed parallel to the plane of the aperture, and the apex directly beneath the apex of the parietal; columellar long slender and high, the interior termination invisible from the aperture; parietal the heaviest of all, reaching nearly to the aperture; angulo-parietal spur united to the parietal in the type, bending outwardly toward the aperture and merging into the posterior peristome; (in the paratype figured and other specimens the angulo-parietal is separated from the parietal by a space). Altitude, 2.01 mm.; diameter, .81 mm.

Type: No. 1094; paratypes, Nos. 1095-1099; Mus. Calif. Acad. Sci., collected by Mr. J. C. Chamberlin May 25, 1921, on **Monserrate Island, Gulf of California.** The type lot consists of seven specimens.

In the occasional separation of the angulo-parietal tooth from the parietal, this species resembles the genus Sterkia where it is normally separated. Part of the type lots of each of the west American species of the genus, *calamitosa, clementina* and *hemphilli* are in the collection of the California Academy of Sciences and the possibility of their having originated from some such ancestral stock as *G. rixfordi* is suggested. On account of the color of the latter and the usual tooth arrangement (as in the type) the species is placed in the section Albinula. The shape of the whorl back of the aperture is strongly suggestive of the condition in *G. armifera* and *G. contracta.*

The species is named for Dr. Emmet Rixford of San Francisco, California.

25. **Planorbis tumens** Carpenter

Planorbis tumens Carpenter, Cat. Mazatlan Shells, British Museum, 1857, p. 181.—Binney, Land and Freshwater Moll. of N. A., part 2, 1865, p. 106, fig. 180.—Cooper, Proc. Calif. Acad. Sci., 2nd Ser., Vol. 3, 1893, p. 217.

Mr. J. C. Chamberlin collected 25 specimens of a large Planorbis at Mulegé, Lower California. Cooper has recorded *P.*

tumens from San Jose del Cabo, and my reason for calling the Mulegé specimens the same is chiefly bibliographic. Until the genus is thoroughly monographed no large species from western North America can be identified with certainty, so involved has the literature become.

26. **Physa diaphana** Tryon

Physa diaphana Tryon, Am. Journ. Conch., Vol. 1, 1865, pp. 168, 224, pl. 23, fig. 11. Oakland, Calif.—Cooper, Zoe, Vol. 3, 1892, p. 20.

Specimens of Physa were obtained at a spring back of Angeles Bay (50 sp.); Mulegé, (12 sp.); and San Evaristo Bay, Espiritu Santo Island, (6 sp.). They are referred to *P. diaphana* with doubt but Cooper listed that species from San Jose del Cabo. West American species of the genus are in almost hopeless confusion so far as nomenclature is concerned and very few specimens can be identified positively.

PLATE VII

(All figures enlarged to 1.14 diameters.)

Fig. 1. *Bulimulus johnstoni*, new species; type No. 1024 (C.A.S. Type Coll.) from Santa Catalina Island, Gulf of California; p. 491.

Figs. 2-6. *Bulimulus johnstoni*, new species; paratypes Nos. 1025-1029 (C.A.S. Type Coll.) from Santa Catalina Island, Gulf of California; p. 491.

Fig. 7. *Bulimulus bakeri*, new species; type No. 1017 (C.A.S. Type Coll.) from San Antonio Point, Lower California (Gulf side); p. 500.

Figs. 8-10. *Bulimulus bakeri*, new species; paratypes Nos. 1018-1020 (C.A.S. Type Coll.) from San Antonio Point, Lower California (Gulf side); p. 500.

Fig. 11. *Bulimulus ceralboensis*, new species; type No. 1021 (C.A.S. Type Coll.) from Ceralbo Island, Gulf of California; p. 490.

Fig. 12. *Bulimulus santacruzensis*, new species; type No. 1030 (C.A.S. Type Coll.) from Santa Cruz Island, Gulf of California; p. 487.

Figs. 13-15. *Bulimulus santacruzensis*, new species; paratypes, Nos. 1031-1033 (C.A.S. Type Coll.) from Santa Cruz Island, Gulf of California; p. 487.

Fig. 16. *Bulimulus slevini*, new species; type No. 1034 (C.A.S. Type Coll.) from Monserrate Island, Gulf of California; p. 488.

Figs. 17-19. *Bulimulus slevini*, new species; paratypes Nos. 1035-1037 (C.A.S. Type Coll.) from Monserrate Island, Gulf of California; p. 488.

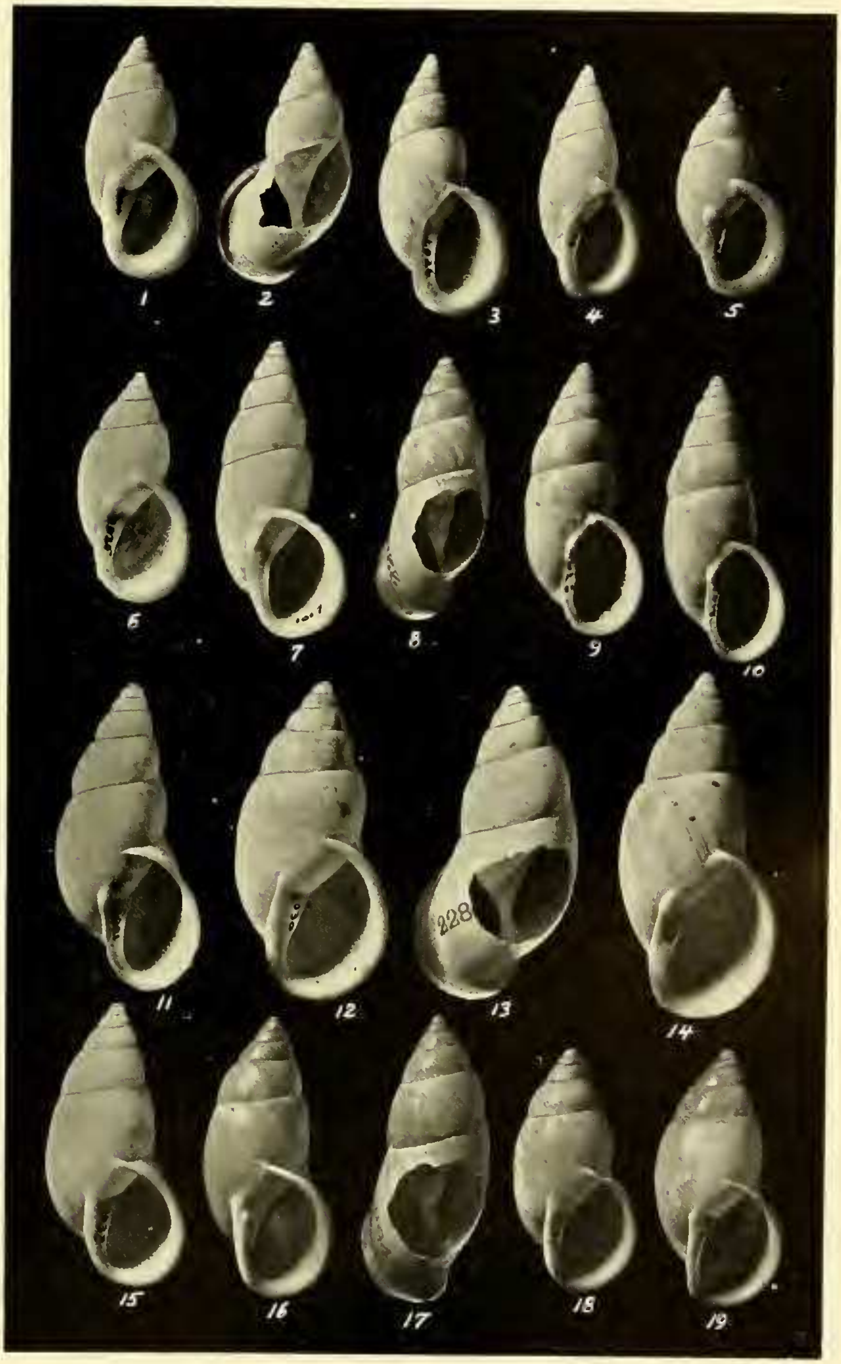
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PLATE VIII

(All figures enlarged to 1.14 diameters.)

Figs. 1-3. *Bulimulus veseyianus* Dall; plesiotypes Nos. 1039-1041 (C.A.S. Type Coll.) from Espiritu Santo Island, Gulf of California; p. 499.

Fig. 4. *Bulimulus ximenez*, new species; type No. 1042 (C.A.S. Type Coll.) from Carmen Island, Gulf of California; p. 497.

Figs. 5-9. *Bulimulus ximenez*, new species; paratypes Nos. 1043-1047 (C.A.S. Type Coll.) from Carmen Island, Gulf of California; p. 497.

Fig. 10. *Berendtia taylori* (Pfeiffer); plesiotype No. 1089 (C.A.S. Type Coll.) from Puerto Escondido, Lower California (Gulf side); p. 506.

Figs. 11-13. *Micrarionta exanimata* (Cooper); plesiotypes Nos. 1100-1102 (C.A.S. Type Coll.) from Monserrate Island, Gulf of California; p. 505.

Figs. 14-15. *Micrarionta peninsularis* (Pilsbry); plesiotypes Nos. 1103-1104 (C.A.S. Type Coll.) from Angeles Bay, Lower California (Gulf side); p. 503.

Figs. 16-20. *Bulimulus dentifer* Mabille; plesiotypes Nos. 1048-1052 (C.A.S. Type Coll.) from Tortuga Island, Gulf of California; p. 492.

Fig. 21. *Bulimulus chamberlini*, new species; type No. 1023 (C.A.S. Type Coll.) from San Diego Island, Gulf of California; p. 494.

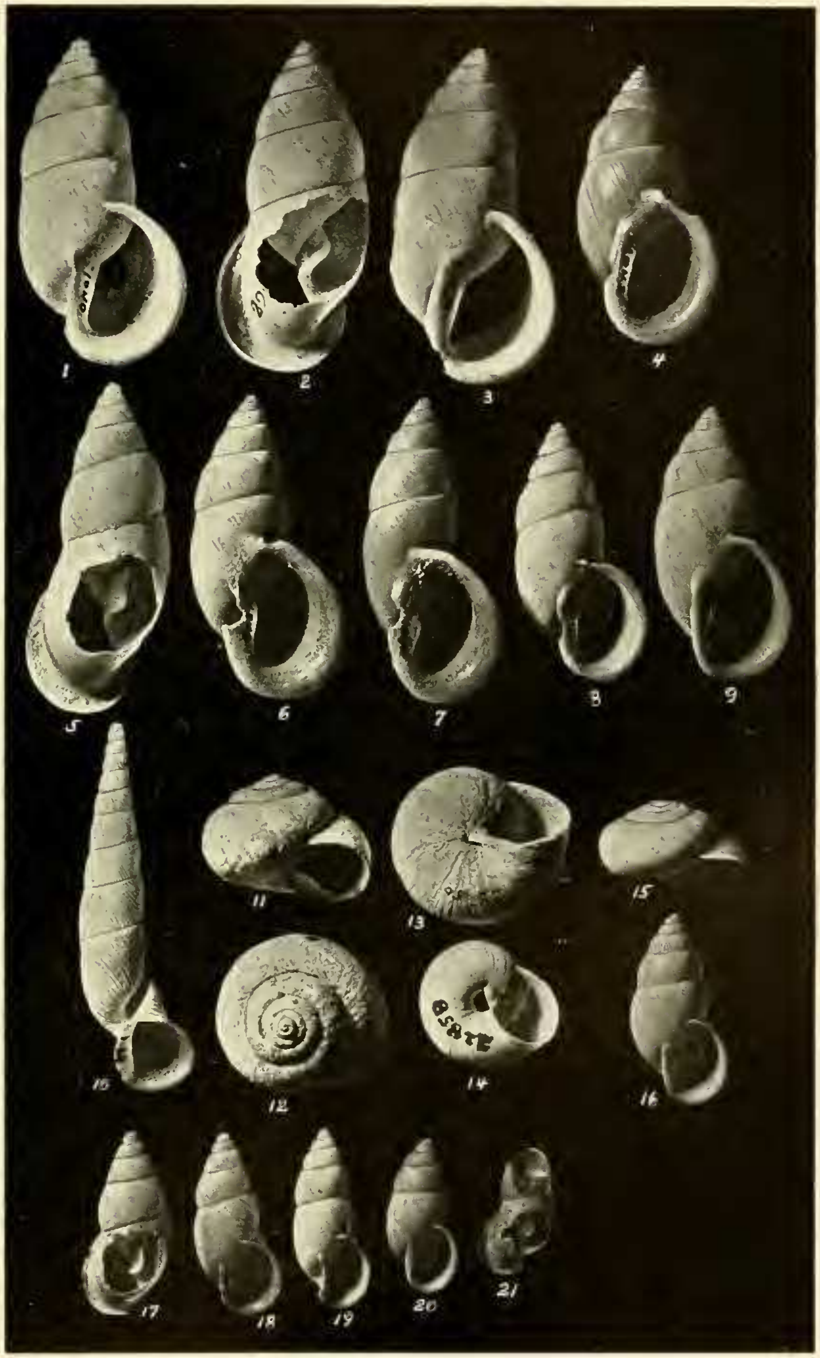
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PLATE IX

(All figures enlarged 2.0 diameters.)

Figs. 1-2. *Cœlocentrum irregulare* (Gabb); plesiotypes (part of type lot) Nos. 1053-1054 (C.A.S. Type Coll.) from Mulegé, Lower California (Gulf side); p. 508.

Fig. 3. *Cœlocentrum oweni*, new species; type No. 1055 (C.A.S. Type Coll.) from Agua Grande, Carmen Island, Gulf of California; p. 511.

Figs. 4-8. *Cœlocentrum oweni*, new species; paratypes Nos. 1056-1060 (C.A.S. Type Coll.) from Agua Grande, Carmen Island, Gulf of California; p. 511.

Fig. 9. *Cœlocentrum insulare*, new species; type No. 1061 (C.A.S. Type Coll.) from Puerto Bellandra, Carmen Island, Gulf of California; p. 509.

Figs. 10-17. *Cœlocentrum insulare*, new species; paratypes Nos. 1062-1070 (C.A.S. Type Coll.) from Puerto Bellandra, Carmen Island, Gulf of California; p. 509.

Figs. 18-24. *Cœlocentrum insulare*, new species; paratypes Nos. 1071-1077 (C.A.S. Type Coll.) from Santa Catalina Island, Gulf of California; p. 509.

Figs. 25-26. *Cœlocentrum insulare*, new species; paratypes Nos. 1078-1079 (C.A.S. Type Coll.) from Monserrate Island, Gulf of California; p. 509.

Figs. 27-28. *Cœlocentrum insulare*, new species; paratypes Nos. 1080-1081 (C.A.S. Type Coll.) from Danzante Island, Gulf of California; p. 509.

Fig. 29. *Cœlocentrum clavigeroi*, new species; type No. 1082 (C.A.S. Type Coll.) from Agua Verde Bay, Lower California (Gulf side); p. 512.

Fig. 30. *Cœlocentrum clavigeroi*, new species; paratype No. 1083 (C.A.S. Type Coll.) from Agua Verde Bay, Lower California (Gulf side); p. 512.

Fig. 31. *Cœlocentrum vanduzeei*, new species; type No. 1085 (C.A.S. Type Coll.) from Puerto Escondido, Lower California (Gulf side); p. 508.

Figs. 32-34. *Cœlocentrum vanduzeei*, new species; paratypes Nos. 1086-1088 (C.A.S. Type Coll.) from Puerto Escondido, Lower California (Gulf side); p. 508.

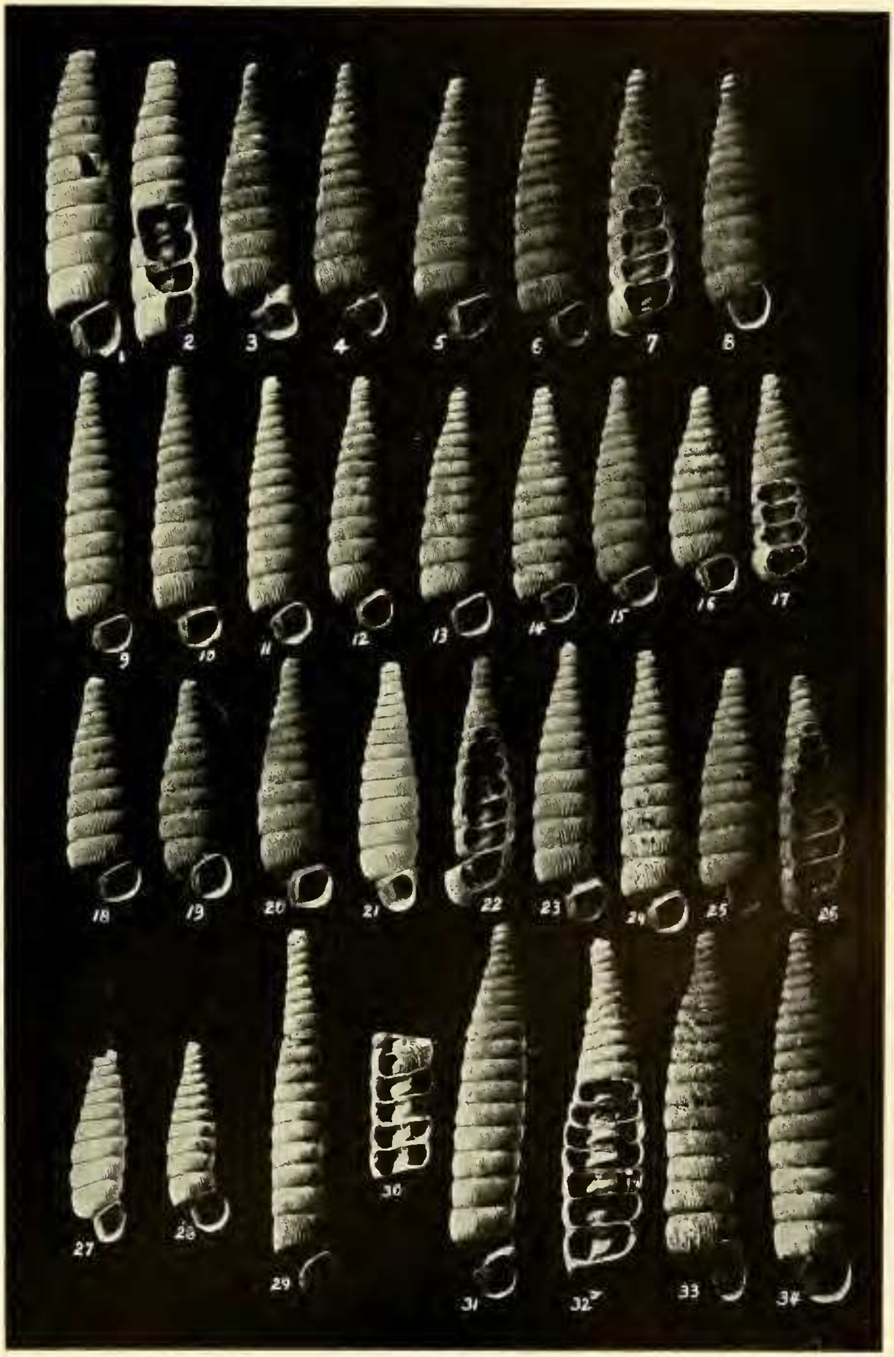
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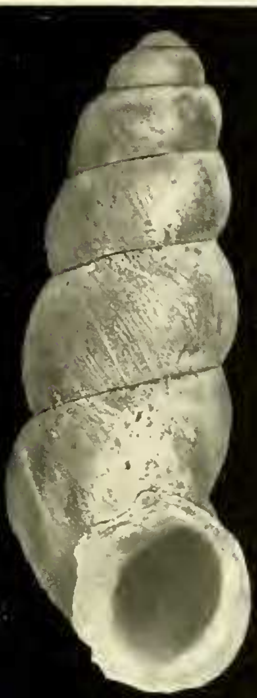
PLATE X

Fig. 1. *Pupoides catalinensis*, new species; type No. 1090 (C.A.S. Type Coll.) from Santa Catalina Island, Gulf of California; enlarged 19.5 diameters; p. 514.

Figs. 2-4. *Pupoides catalinensis*, new species; paratypes Nos. 1091-1093 (C.A.S. Type Coll.) from Santa Catalina, Gulf of California; enlarged 19.5 diameters; p. 514.

Fig. 5. *Gastrocopta rixfordi*, new species; type No. 1094 (C.A.S. Type Coll.) from Monserrate Island, Gulf of California; enlarged 17.2 diameters; p. 515.

Figs. 6-8. *Gastrocopta rixfordi*, new species; paratypes Nos. 1095-1096 (C.A.S. Type Coll.) from Monserrate Island, Gulf of California; enlarged 17.2 diameters; p. 515.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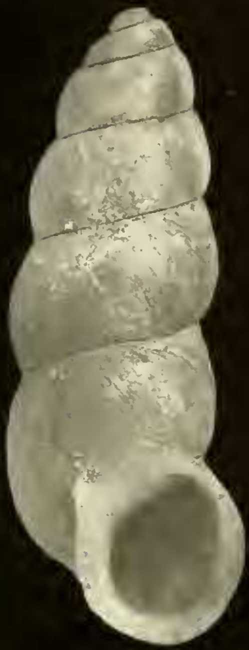
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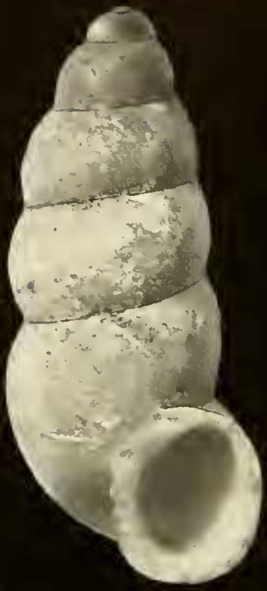
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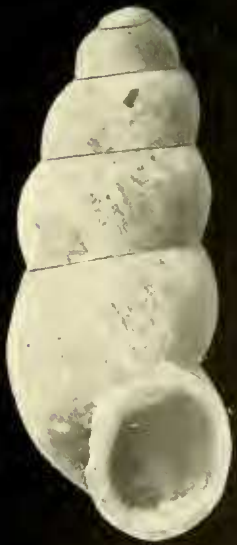
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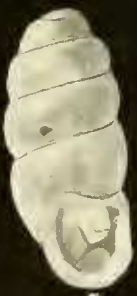
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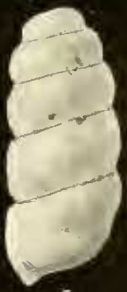
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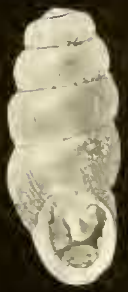
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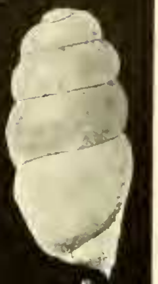
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PLATE XI

Fig. 1. *Micrarionta peninsularis* (Pilsbry); plesiotype No. 1103 (C.A.S. Type Coll.) from Angeles Bay, Lower California (Gulf side); enlarged 24.6 diameters; p. 503.

Fig. 2. *Bulimulus ceralboensis*, new species; paratype No. 1022 (C.A.S. Type Coll.) from Ceralbo Island, Gulf of California; enlarged 31.9 diameters; p. 490.

Fig. 3. *Bulimulus johnstoni*, new species; type No. 1024 (C.A.S. Type Coll.) from Santa Catalina Island, Gulf of California; enlarged 24.6 diameters; p. 491.

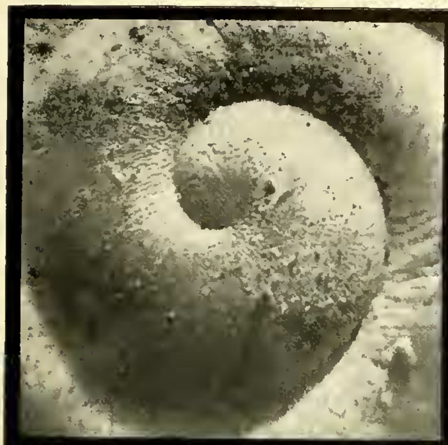
Fig. 4. *Bulimulus ceralboensis*, new species; paratype No. 1022 (C.A.S. Type Coll.) from Ceralbo Island, Gulf of California; enlarged 17.9 diameters; p. 490.

Fig. 5. *Cœlocentrum insulare*, new species; type No. 1061 (C.A.S. Type Coll.) from Bellandra Bay, Carmen Island, Gulf of California enlarged 12.9 diameters; p. 509.

Fig. 6. *Cœlocentrum clavigeroi*, new species; type No. 1082 (C.A.S. Type Coll.) from Agua Verde Bay, Lower California (Gulf side); enlarged 12.9 diameters; p. 512.

Fig. 7. *Cœlocentrum vanduzeei*, new species; type No. 1085 (C.A.S. Type Coll.) from Puerto Escondido, Lower California; enlarged 12.9 diameters; p. 508.

Fig. 8. *Cœlocentrum oweni*, new species; type No. 1055 (C.A.S. Type Coll.) from Agua Grande, Carmen Island, Gulf of California; enlarged 12.9 diameters; p. 511.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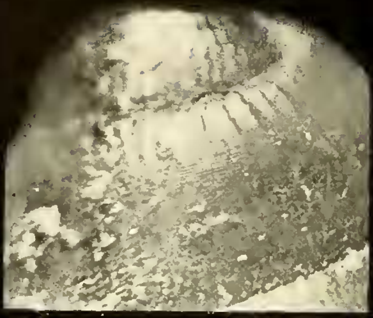
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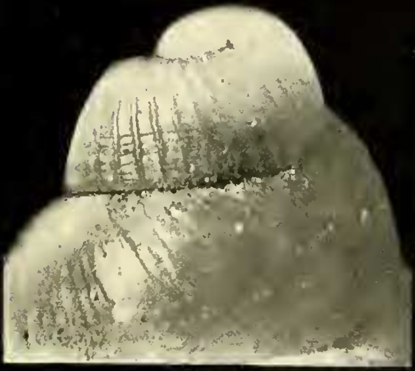
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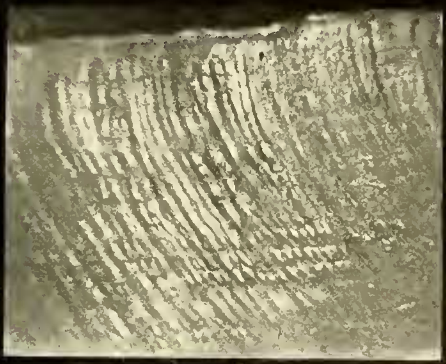
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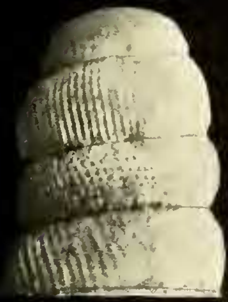
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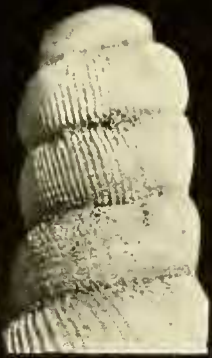
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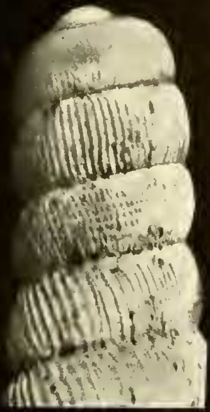
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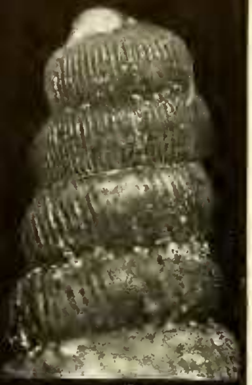
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